Sensapalooza: Guided Tour of the New Silicon Senses

Organizers
Kathryn Saunders
ThinkTech
245 Davenport Road, 3rd Floor
Toronto, Ontario M5R 1K1
Canada
+1.416.200.4316
panels-s2001@siggraph.org

James Geary
TIMEeurope.com

Host
James Geary
TIMEeurope.com

Participants
Ferdinando (sandro) Mussa-Ivaldi
Northwestern University

Henri Lustiger-Thaler
Aerome USA

Thomas A. Furness III
University of Washington

Hiroshi Ishii
Massachusetts Institute of Technology
tangible.media.mit.edu/

Ellwood Ivey
Trisenx, Inc.

Alex Waibel
Carnegie Mellon University

Commentators
Andrew Glassner
Independent Consultant

Monika Fleischmann
GMD - Forschungszentrum Informationstechnik GmbH

Rosalind W. Picard
Massachusetts Institute of Technology

Human beings are embedding computer chips in their bodies to enhance, extend, or repair their senses, while computers are gaining the ability to see, hear, smell, taste, and touch. And once a computer has its own sensorium, it's conceivable that it could at some point learn to think.

This remarkable convergence of body and machine is empowered by merging advanced computing technology with the human nervous system, a combination that holds could restore sight to the blind and help victims of paralysis regain partial use of their limbs. The flexh-chips convergence is also giving individuals bionic senses, such as the ability to see infrared radiation or to feel objects at a distance. Some futurists even suggest that computers will eventually enable extra-sensory perception.

This Special Session is a combination of talk show and television cooking program, with a Greek chorus attached. Six guests (one for each of the five senses and one for the sixth sense, mind) demonstrate leading-edge technologies that show how the human sensorium is being augmented with sophisticated computer chips. During and after the demos, members of the Greek chorus contribute their own observations and comments. The audience participates by entering questions on the Special Session Web site via wireless network connections.

The goal is to provide a compelling and provocative overview of some of the newest technologies that could soon become part of our computers and our bodies.

Sight

Picture this. You are walking down a street in a foreign city, wondering how to find a particular restaurant, where you've arranged to meet an old friend. When you enter a few commands in a small computer attached to your belt, a map of the city appears in the air before you, and you notice that the quickest route to the restaurant is outlined in yellow. When you find the right street, you can't quite make out a sign in the distance. A light touch to your glasses magnifies the image, confirming that this is indeed the restaurant. You enter the restaurant and recognize your friend at a table. And now picture one more thing: You are legally blind. This scenario is far from improbable. In fact, it's already a reality. Visual prosthetics (electronic implants in the eye, the optic nerve, or the brain) are enabling blind people with certain eye diseases to see again, and retinal displays can project virtual images directly into the eye. These technologies are bringing new dimensions to the sense of sight that could provide eyes in the back of your head and the ability to see things beyond the normal visible spectrum.

Hearing

Voice operation and speech synthesis are increasingly commonplace in mobile phones, automobile navigation systems, and other devices in which portability and ease of use are key. Research is even under way to replace familiar desktop icons with "earcons," audible tones that would alert users to incoming email, changes in stock prices, or important news bulletins.

For mobile devices, this technology would allow users to keep their eyes on the road, the sidewalk, or other travelers instead of casting furtive glances at a computer screen. A travelling day trader could hear the steady murmur of the Dow, for example; when it goes up, perhaps the earcon is a high-pitched squeal of fireworks; when it goes down (who knows?), perhaps the sound of a flushing toilet. The abilities of computers to hear and parse human speech are being put to use in portable devices that provide real-time translations within certain domain-specific subject areas. Other research is dedicated to improving hearing by making the cochlear implant even more like the biological system it emulates. Researchers are finding that the best way to try to match what the senses can do is to study the biology and then replicate key computational concepts in electronics.

Smell

Electronic noses, arrays of odor-sensitive electrochemical sensors linked to high-powered computers have been in use for several years, primarily to trace explosive residues, analyze blood alcohol levels, and carry out quality control tests in the food and beverage industries. A new generation of e-noses is beginning to replicate the speed, sensitivity, and discrimination of the human nose. Soon, a digital proboscis will be able to do everything from assist in medical diagnoses to identify leaks of hazardous substances. Thanks to these new engines of olfaction, your family physician may soon be developing a preliminary diagnosis based on information gleaned from an electronic nose in your phone.

Computers can also pass gas. Firms in the US, Europe, and Israel have developed technology that is, in effect, a video player for the nose. When you insert a scent cartridge (a white rectangular box that looks very much like an ordinary video cassette but contains six prefabricated scents) into one of these devices, it releases appropriate aromas in sync with scenes from a video or

film presentation. These firms claim that they can create any desired fragrance, and that the amount, intensity, and duration of the smells can be precisely controlled. Fragrant Web stes, scented emails, odoriferous interactive games, and aromatic online advertising may be coming soon to a computer screen near you.

Taste

Companies and research labs are developing electronic tongues that can sample foods, beverages, and even blood. At least one firm plans to deliver fast food over the Internet, which means that die-hard geeks might one day never have to leave their desktops, not even to order pizza. Using technology similar to the scent controller described above, this machine works like a gustatory fax; it transmits a message to the user's computer in response to a click on a taste-enabled Web site. From this message, a miniature kitchen attached to the user's computer then whips up the appropriate flavor. Some researchers imagine the day when miniature taste-sensor technology will be attached to the ends of chopsticks and spoons. Dip your chopsticks into a meal, and they will not only tell you what you are eating, but also list the ingredients and provide you with the recipe. Back home in your Internet-enabled kitchen, just plug the chopsticks into the fridge, and the fridge will call up the recipe on the screen and order any missing ingredients.

Touch

Technology is getting onto, and under, our skin. Computers are moving off the desktop into everyday objects, and human bodies, putting people "in touch" with technology in an ever-more-intimate embrace. Physicians are implanting electrodes into patients to rehabilitate atrophied muscles, prevent epileptic seizures, and restore motor function lost as a result of paralysis. Engineers are creating hybrid prosthetics such as ankles, legs, and knees in which silicon chips are melded with living tissue. Computer scientists are designing haptic (from the Greek word meaning "to touch") interfaces that allow users to reach out and touch digital information, transforming the plain old graphical user interface into a graspable user interface. By coupling digital information with everyday objects like tabletops, appliances, and coffee cups, the physical world is becoming one enormous interface.

Mind

Since bodies are essential to the emergence of mind in human beings, it makes sense to assume that artificial creatures need bodies, too, if they are ever to become aware, intelligent, and, perhaps someday, even conscious. The rallying cry for this kind of research might be summarized in a slogan: "No sensation without representation." Computer scientists are providing physical representations for these possible minds by taking Alan Turing's advice: give machines – both virtual ones inside computers and physical ones in the form of robots – the best sense organs that money can buy. Researchers are also growing neurons on silicon chips to create the ultimate man-machine interface, one that could help victims of neurodegenerative brain disorders and empower electronic devices that can be operated by thought alone.

James Geary–TIMEeurope.com
James Geary is editor, special projects at TIMEeurope.com. He has written a dozen cover stories on subjects as diverse as language extinction, the neurological basis of memory, and the attempts of European politicians to create a "Third Way." He has edited three Time special issues – "The New Age of Discovery" (1997), "Visions of Europe" (1998), and "Fast Forward Europe" (2000) – as well as special reports on telecommunications, technology, and the Internet in Europe. He won Time Inc.'s President's Award, granted in recognition of excellence in generating ideas and delivering results, for the "Visions of Europe" special issue.

In June 2000, he won the NetMedia 2000 European Online Journalism Award for science with his article "What Is Life?" which explores one man's research in the field of artificial intelligence. In his spare time, he regularly contributes book reviews to the James Joyce Quarterly. He also composed the libretto for the dramatic song cycle, "Broken English," which premiered in Amsterdam in August 1997. His book about computers and the human senses, The Body Electric: An Anatomy of the New Bionic Senses, will be published by Weidenfeld & Nicolson in the fall.

Kathryn Saunders
Kathryn Saunders is a founding partner of ThinkTech, a consulting firm that designs and develops location-based and e-based experience strategies. She has been actively involved with SIGGRAPH for many years. She is Panels Chair for 2001, and for SIGGRAPH 99, she chaired Emerging Technologies, where she developed and executed the Millennium Motel concept and curated several elements including the entry portal and Route 66.

Trained as an architect, she practiced architecture with two of Canada's leading design firms and has taught architecture at two Canadian universities. Prior to her current post, she was executive director of the Digital Media Institute and creative director, digital media, at the Royal Ontario Museum. At the museum, she developed MYTHICA, an educational entertainment destination that uses a profiling system, wireless technologies, and intelligent autonomous agents to deliver personalized information before, during, and after a visit, based on the visitor's behavior and aspirations. A recipient of many interactive media awards, she has consulted and lectured around the globe from North America to Saudi Arabia and Japan.

Ferdinando (Sandro) Mussa-Ivaldi
Sandro Mussa-Ivaldi is a faculty member at the Medical School of Northwestern University. He holds appointments with the departments of physiology, physical medicine and rehabilitation, biomedical engineering and mechanical engineering.

Originally from Turin, Italy, he received a graduate degree in physics from the University of Turin and a PhD in biomedical engineering from the University of Genova and the Polytechnic of Milan.

His past teaching and research credits include:

- The University of Provence, where he worked with Gabriel Gauthier on coordination of eye and hand movements.
- The department of computer science of the University of Genova as a research fellow, where he worked with Pietro Morasso on computational models of handwriting.
- MIT, where he collaborated with Emilio Bizzi and Neville Hogan on a number of studies aimed at understanding the interplay of neural, mechanical, and computational factors in the control of arm movements.

A significant portion of his research is conducted within the Sensory Motor Performance Program of the Rehabilitation Institute of Chicago. His current studies is the focus on the mechanisms underlying the ability of the central nervous system to learn new movements and to adapt previously learned movements to changes in the body as well as in environmental dynamics. Current knowledge indicates that the brain learns new patterns by establishing long-term modifications in the ability of nerve cells to exchange information with each other. Recently, his research team developed a hybrid system that establishes a bi-directional interaction between living neural tissue and a simple mobile robot. They are trying to exploit the behaviors that emerge from this interaction as a window into the information processing of the brain tissue and, in particular, on the mechanisms of synaptic plasticity.

Henri Lustiger-Thaler
Henri Lustiger-Thaler has been associated with Aerome Scent Communications since the founding of the Company in 1997. He received his doctorate from Université de Montréal, completed his post-doctorate work at Cambridge University, and has been a visiting fellow at Dartmouth College and the University of Rome at La Sapienza. He has published several books and numerous articles on culture and global communication. He is considered to be the foremost specialist on scent communications in the world today.

Thomas A. Furness III
Thomas A. Furness III is a pioneer in virtual interface technology and virtual reality. He received a BS in electrical engineering from Duke University and a PhD in engineering and applied science from the University of Southampton. He is currently professor of industrial engineering and adjunct professor of electrical engineering and technical communication at the University of Washington, and is the founding director of the university's Human Interface Technology Laboratory. Prior to joining the University of Washington, he served a combined 23 years as an officer and civilian at the Armstrong Laboratory at Wright-Patterson Air Force Base, where he developed advanced cockpits and virtual interfaces for the US Department of Defense. He is the author of the Super Cockpit program and served as the chief of visual display systems and Super Cockpit director until he moved to Seattle in 1989.

The overall mission of the Human Interface Technology Laboratory is to empower humans by building better interfaces to advanced machines that will unlock the power of human intelligence and link minds globally. The HIT Lab consists of 120 faculty members, professional staff, students, and visiting scholars. It is supported in part by the Virtual Worlds Consortium, a group of 47 companies that provide funding and in-kind annual contributions to the laboratory's research agenda. The laboratory's work encompasses development of hardware and software technologies, human factors, and applications development associated with advanced interfaces with a focus on virtual reality.

Hiroshi Ishii
Hiroshi Ishii's research focuses on design of seamless interfaces among humans, digital information, and the physical environment. At the MIT Media Lab, he founded and directs the Tangible Media Group, which is pursuing a new vision of human-computer interaction: Tangible Bits. His team seeks to change the "painted bits" of graphical user interfaces to "tangible bits" by giving physical form to digital information:

From 1988 to 1994, he led a research group at the NTT Human Interface Laboratories, where his team invented Team-WorkStation and ClearBoard. In 1993 and 1994, he was a visiting assistant professor at the University of Toronto. He is actively engaged in research on human-computer interaction and computer-supported cooperative work. He served as associate editor of ACM TOCHI (Transactions on Computer Human Interactions) and ACM TOIS (Transactions on Office Information Systems). He also serves as a program committee member of many international conferences including ACM CHI, CSCW, UIST, SIGGRAPH, Multimedia, Interact, and ECSCW. He received a BE in electronic engineering, and ME and PhD degrees in computer engineering from Hokkaido University.

Ellwood Ivey
Ellwood Ivey attended the School of Business at Savannah State College and completed the Sales and Marketing program at Draughons Business College. His many accomplishments include building a 92-member sales team for a major international health food company. He has served as a technology consultant to Hoechst Celenese Corp., a $16 billion conglomerate. In 1991, he founded the D.U.I.E. Project, managed development of its revolutionary technology (hydrocarbon specific sensor), and facilitated its joint venture and licensing deal valued at nearly $10 million. He currently holds four patents, two service marks, two trademarks, numerous copyrights, and other proprietary properties.

Alex Waibel
Alex Waibel is professor of computer science at Carnegie Mellon University and Universität Karlsruhe. He directs the Interactive Systems Laboratories at both universities, where his research emphasis is in speech recognition, handwriting recognition, language processing, speech translation, machine learning, and multimodal and multimedia interfaces. At Carnegie Mellon, he also serves as associate director of the Language Technology Institute and as director of the Language Technology PhD program. He was one of the founding members of CMU's Human Computer Interaction Institute and serves on its core faculty.

He was one of the founders of C-STAR, the international consortium for speech translation research, and served as its chairman from 1998 to 2000. He also codirected Verbmobil, the German national speech translation initiative. His work on time delay neural networks was awarded the IEEE Best Paper award in 1990, and his work on speech translation systems received the Alcatel SEL Research Prize for Technical Communication in 1994. He received a BS in electrical engineering from the Massachusetts Institute of Technology in 1979, and M. and PhD degrees in computer science from Carnegie Mellon University in 1980 and 1986.

Andrew Glassner
Andrew Glassner is a novelist, screenwriter, and consultant in computer graphics. He began working in computer graphics in 1978, and has carried out research in the field at the New York Institute of Technology's Computer Graphics Lab, Case Western Reserve University, the IBM T.J. Watson Research Center, the Delft University of Technology, Bell Communications Research, Xerox PARC, and Microsoft Research. A popular writer and speaker, he has published numerous technical papers on topics ranging from digital sound to 3D rendering. His book 3D Computer Graphics: A Handbook for Artists and Designers has taught a generation of artists through two editions and three languages. He created and edited the "Graphics Gems" series and the book An Introduction to Ray Tracing. He wrote the two-volume text Principles of Digital Image Synthesis. His most recent book is Andrew Glassner's Notebook, a collection of the first three years of his regular column by the same name in IEEE Computer Graphics & Applications. He has served as Papers chair for SIGGRAPH 94, founding editor of the Journal of Graphics Tools, and editor-in-chief of ACM Transactions on Graphics. He wrote and directed the short film "Chicken Crossing," which premiered at the SIGGRAPH 96 Electronic Theater, and designed the highly participatory game "Dead Air" for The Microsoft Network, where he wrote and directed the live-action pilot episode. He is currently at work on his second novel and consulting on computer graphics, storytelling, and story structure for the computer game and online entertainment industry. In his spare time, he paints, plays jazz piano, kayaks, and hikes. He holds a PhD in computer science from the University of North Carolina at Chapel Hill.

Monika Fleischmann–imk.gmd.de:8081/people/fleischmann.mhtml
Monika Fleischmann studied visual arts, theater, and computer graphics. Since 1992, she has been artistic director of the institute for media communication and since 1997, head of the MARS Exploratory Media Lab at the German National Research Center for Information Technology (GMD) outside Bonn. She also teaches at the Academy of Design in Zurich. Her work, always produced with her partner, Wolfgang Strauss, has been exhibited at the Centre Pompidou, the Museum for Design, the Museum of Modern Art (New York), and events such as the annual SIGGRAPH conference, Imagina, Art Futura, ISEA, and Ars Electronica. In 1992, her Home of the Brain was awarded wih the Golden Nica for interactive art at Ars Electronicaz. Her work ranges among art, science, and technology. In theoretical and practical studies, she explores the creative potential of computer technologies. Her main research topics are human computer interfaces combined with interactive virtual environments and perceptive processes.

Rosalind W. Picard
Rosalind W. Picard is founder and director of the Affective Computing Research Group at the Massachusetts Institute of Technology Media Laboratory. She holds a bachelors in electrical engineering from the Georgia Institute of Technology and masters and doctorate degrees in electrical engineering and computer science from MIT. The author of over 80 peer-reviewed scientific articles in pattern recognition, multidimensional signal modeling, computer vision, and human-computer interaction, she is internationally known for pioneering research on content-based video retrieval and on giving computers the ability to recognize and respond to human emotional information. She is co-recipient with Tom Minka of a "best paper" award (1998) from the Pattern Recognition Society for their work on interactive machine learning with a society of models. Her award-winning book, Affective Computing (MIT Press, 1997), lays the groundwork for giving machines the skills of emotional intelligence. Her group's research on affective and wearable technologies has been featured in national and international public forums such as *The New York Times, The London Independent, Scientific American Frontiers, Time, New Scientist, Vogue,* and PBS and BBC specials.